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NPOESS Data Exploitation (NDE)

Tailoring Tools Workshop Report

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National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite, Data, and Information Service (NESDIS)
Office of Systems Development (OSD)

ABSTRACT: **Report of a meeting to identify software to be evaluated for adoption by NESDIS for modifying NPP and NPOESS satellite data products to meet end user requirements.**

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1. INTRODUCTION

A. NPOESS

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) will replace the National Oceanic and Atmospheric Administration (NOAA) Polar-orbiting Operational Environmental Satellite (POES) Program and the Department of Defense (DOD) Defense Meteorological Satellite Program (DMSP). Starting in late 2009, with a risk reduction NPOESS Preparatory Project (NPP) satellite, NPOESS will provide environmental remote sensing capability to four central processing facilities, called "Centrals," via its Interface Data Processing Segment (IDPS). The Centrals will be responsible for providing NPOESS global coverage Stored Mission Data (SMD) to environmental satellite users.

B. NDE Mission and Objectives

NOAA's NPOESS Data Exploitation (NDE) project is responsible for providing satellite information to civilian users. The project consists of an interdependent group of people who engage in processes to develop an NDE system that will include all of the associated equipment, facilities, material, computer programs, firmware, technical documentation, services, and personnel required for operations and support.

NDE's primary mission is to provide products derived from NPOESS observations to NOAA's operational and climate communities and other civilian customers. In order to fulfill the mission, NDE will acquire the resources necessary to achieve the following objectives:

- Disseminate NPOESS Data Records to customers
- Generate and disseminate tailored NPOESS Data Records (versions of NPOESS Data Records in previously agreed alternative formats and views)
- Generate and disseminate NOAA-unique products (augmented environmental products constructed from NPOESS Data Records)
- Deliver NOAA-unique products and associated metadata to the NOAA Long-Term Archive
- Provide services to customers, including a Help Desk, NDE product training, product enhancement, and implementation support across NOAA
- Coordinate NPOESS-related activities across NOAA
  - Assist with planning for the implementation of NPOESS data by user systems
  - Ensure end-user preparedness for NPOESS data
- Develop a sustainable system that meets its customer needs
- Provide software for NPOESS Data Record format conversion and other data manipulations

C. Purpose of the Workshop

NDE will select software to tailor NPP and NPOESS data records and derived NOAA-unique products (NUPs) to satisfy the requirements of NOAA applications. The NDE team analyzed a variety of Commercial Off The Shelf (COTS), Government Off The Shelf (GOTS), and Open Source tool suites to identify software to satisfy the project's tailoring requirements. During the Critical Design Review (CDR) of September

18th, 2007, the team announced IDL and McIDAS as its choice. Stakeholders attending the CDR submitted nine Requests for Action (RFA) regarding the selection. They asked NDE to reconsider IDL and McIDAS, indicating that no single tailoring tool could satisfy the requirements of all the stakeholders. Some stakeholders indicated that NDE had not provided compelling reasons for replacing the current tailoring software.

Consequently, NDE invited its stakeholders to participate in a Tools Workshop on November 27th and 28th, 2007 at the NOAA Satellite Operations Facility (NSOF) in Suitland, MD. The purpose of the workshop was to review the functions the tools are to perform, to identify the selection criteria for tools, and to review and discuss candidate tools.

The workshop was facilitated by James G. Yoe, the NDE Systems Integration Coordinator and by Geoffrey Goodrum, NDE's System Architect. On the first day, the NDE Architect and senior developers briefed the stakeholders on the architectural assumptions and constraints. NESDIS Product Area Leads (PALs) delivered briefings on the software currently used to tailor polar satellite data products. Representatives from the AWIPS Evolution project, European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the NPOESS Integrated Program Office (IPO) delivered briefings about their tailoring approaches. (See "NDE Tailoring Tools Workshop" http://projects.osd.noaa.gov/nde/public-documents.htm)

The second day was devoted to defining the criteria to be applied during the selection process and with preliminary assessments of each known tool's capabilities in relation to the criteria. At the conclusion of the Workshop, ideas for how to proceed (Next Steps) were presented by members of the NDE Management Team.

D. Document Purpose

This report provides descriptions of the tailoring software products, the selection criteria identified during the workshop, and a schedule of planned activities leading to final selection and implementation of the choice(s). The schedule, as well as product characteristics details and criteria definitions, was refined during internal team meetings and meetings with key stakeholders that followed the workshop.

2. TOOLS

The participants agreed to consider three topics during the workshop: the functions the tools are required to perform, the evaluation criteria applicable to all tools, and the characteristics of existing software tools that are known to be capable of performing at least some of the required tailoring functions. .

A. Functions the Tools Perform

1) Formatting
   The ability to alter a generic NPOESS Data Record (xDR) from either HDF5 (IDPS' output standard) or NetCDF4 (STAR's output standard) to formats used in customer applications. Generating products in BUFR and GRIB formats is essential and of highest priority because these are required for product assimilation in NCEP models. NDE will examine tools to convert to: GeoTIFF, McIDAS, HDF4, HDF5, HDF-EOS, and NetCDF formats.

2) Projection
   The ability to alter the map projection of an xDR or NOAA-Unique Product (NUP). The tool must read and write standard projections such as Mercator, polar stereographic, Plate Carrée, Equirectangular, Geographic, Cartesian, Equidistant Cylindrical, etc.

3) Regridding
   The ability to represent the same product in terms of various spatial resolutions. For example, the ability to create a .05° geolocated image after spatially averaging the pixels from a .01° grid.

4) Swath-to-Grid (Standard) Conversion
   The ability to select and process temporal and spatial subsets of swath data and reprocess them as gridded products of varying spatial resolutions, or to convert the selected swath data directly to a standard projection.

5) Sub-sampling (or down-sampling)
   The ability to create smaller data products from larger ones by selecting a single member (pixel, channel, etc.) to represent the entire set from which it is taken.

6) Sub-setting and Aggregation
   Sub-setting is the ability to create smaller products from larger products by extracting from a larger file only the portion(s) that are of interest.

   Aggregation is the ability to combine multiple data products into a single, typically larger, product. Examples include combining granules, or creating a time series of like data products.

7) Visualization
The ability to create visual representations of satellite observations.

B. Tool Selection Criteria

1) Suitability
Does the software offer one or more of the required functional capabilities?

2) Life Cycle Costs
What would NESDIS be obligated to pay for acquisition, licensing, and support of the software?

3) Performance
Can the software be used in the NDE System Test and Operational environments at acceptable levels of resource usage and execution time? "Acceptable" will be determined by a combination of anecdotal user reports, from published reports of independent testers, or from performance metrics available from the software's provider. (In the case of COTS, the vendor provides the software. If the tool is GOTS or Open Source, the community that maintains the software is its provider.)

4) Support & Sustainability
a) Support - Is it likely that resources will be available to answer questions and diagnose problems in a timely fashion throughout the period of time that the software is used at NESDIS?
b) Sustainability - Is it likely that the owners of the software will provide tested updates and repairs throughout the period of time that the software is used at NESDIS?

5) Training Availability
Is training provided? How is the training delivered (i.e., classes, on-line, embedded help pages, etc.)? What is the cost of training?

6) Customer Usability
Will end-users be able to install and run the software? This criterion supports NDE's goal of allowing users to perform tailoring operations. Rather than performing many similar operations on the same product in the NDE production environment, NDE seeks to reduce its operational cost by making one version of the product available to many users.

7) Usability

What is the likelihood that a tool's user will be able to configure it to perform desired operations without referencing documentation? How accessible and understandable is the documentation? How intuitive is the user interface?

8) Security Vulnerability

To what extent were weaknesses detected when the source code was parsed for vulnerabilities? (Inadequate validation of input and inadequate buffer overflow control are common vulnerabilities.) NDE will use Open Source diagnostic programs on trial versions of candidate tools. Rough Auditing Tool for Security (RATS) scans C, C++, Perl, PHP and Python source code and flags common security related programming errors such as buffer overflows and TOCTOU (Time Of Check, Time Of Use) race conditions. *Flawfinder* is another Open Source program that examines source code and reports possible security weaknesses (``flaws'') sorted by risk level.

9) Interoperability across Platforms

To what extent can the software communicate, execute programs, or transfer data between functional units that use different operating systems (e.g., Linux and AIX)?

C. Initial List of Tools

With regard to formatting, certain open source and NWS or NESDIS-developed tools satisfy essential requirements and will be implemented without further evaluation. These include

1. NCEP BUFRLib and the NCEP GRIBLib, which are software libraries of product-specific tools developed by the National Centers for Environmental Prediction (NCEP). For a supported data product provided in a supported input format, applications can call the libraries to reformat a record in the World Meteorology Organization's (WMO) standard Binary Universal Form for the Representation of meteorological data (BUFR) or the WMO standard for gridded data, GRIdded Binary (GRIB).

2. The Unidata netCDF library is also an open source collection. NetCDF (network Common Data Form) is an interface for array-oriented data access and a library that provides an implementation of the interface. The netCDF library defines a machine-independent format for representing scientific data. Together, the interface, library, and format support the creation, access, and sharing of scientific data. NetCDF library is essential because of the STAR decision to create all NOAA-unique products as netCDF records. NOAA-unique products derived from NPP and NPOESS observations will first be created according to the STAR netCDF standard, then translated into other formats (e.g., BUFR or GRIB for the NWS).

3. An HDF5 Lib is part of HDF data management capability provided by the HDF Group (THG) to read and write HDF5 data files.

4. CriS/ATMS Code Tables will be developed by STAR from a foundation of unique code tables used to convert HDF-EOS records from the NASA AIRS sensor on the AQUA satellite and to read and write the BUFR observations from the IASI sensor on EUMETSAT's Metop satellite. Because the CrIS and ATMS products from NPP/NPOESS will be similar to the AIRS and IASI input, these tables are expected to be reusable for atmospheric soundings during NPP and NPOESS. It is possible that the BUFR and GRIB output definitions developed for CrIS/ATMS will be incorporated into the NCEP BUFR and GRIB Libraries. If that becomes the case, NDE will use the NCEP Code Tables.

5. STAR's MIRS BUFR Code Tables will be installed. These definitions are already being developed for the purpose of generating ATMS microwave data for NWS use. As is the case with the CrIS/ATMS Code Tables, they may be integrated with the NCEP BUFR and GRIB Libraries at some future date. If that becomes the case, NDE will use the NCEP Code Tables.

Required Tool Name
NCEP BUFRLib
NCEP GRIBLib
netCDF4 library
HDF5 Lib
CriS/ATMS Code Tables (tbc)
MIRS BUFR Code Tables (tbc)

Table 1: Required Tools

During the workshop a list of externally developed tools was identified by the participants. The list is not assumed to be all-inclusive. Rather, it is the subset of products known to NESDIS and understood to be widely used and well-supported. The seven (7) software packages the participants suggested as being strong candidates for use during NDE tailoring are:

1. IDL, a proprietary product provided by the ITT Visual Information Solutions Company. Two add-on integrated applications are also available: ENVI for visualization and IAS for analysis of data and imagery and deployment of large imaging. **NOTE** that starting with version 7.0, IDL will no longer be executable on AIX platforms, unless customers provide financial support for the development and testing. Unless the company changes its support plan, NDE's usage of IDL would be restricted to off-line Linux environments dedicated to monitoring and trouble-shooting. IDL could not be invoked to perform real time operations in the the AIX environments of NDE: Science Algorithm Development & Integration Environment (SADIE), System Test in which user products will be generated during NPP, nor in the AIX Operational environment thereafter.

2. NCL, the NCAR Command Language is a free interpreted language designed specifically for scientific data processing and visualization. It can read and write netCDF-3, netCDF-4 classic, HDF4, binary, and ASCII data, and read HDF-EOS2, GRIB1 and GRIB2. The graphics are of good quality and highly customizable.

3. MATLAB, a proprietary numerical computing environment and programming language provided by The MathWorks. The tool allows easy matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs in other languages.

4. McIDAS V, an upcoming release of The Man-computer Interactive Data Access System (McIDAS) developed at the University of Wisconsin to track cloud features and visualize data from geostationary satellites. The "V" release will include the Integrated Data Viewer (IDV) and VisAD, a visualization library that supports a universal numerical data model, flexible 2-D and 3-D displays, a distributed component architecture, and flexible user interaction and collaboration.

5. GDAL is the Geospatial Data Abstraction Library, a translator library for raster geospatial data formats that is released under an Open Source license by the Open Source Geospatial Foundation. As a library, it presents a single abstract data model to the calling application for all supported formats. It also comes with a variety of command line utilities for data translation and processing.

6. ImageMagick is an Open Source software suite used to create, edit, and compose bitmap images. It can read, convert and write images in over 100 formats. It's used to translate, flip, mirror, rotate, scale, shear and transform images, adjust image colors, apply various special effects, or draw text, lines, polygons, ellipses and Bezier curves. It has a command line interface or it can be invoked from programs written in most languages. It runs on all major operating systems.

7. GraphicsMagick is an Open Source tool that supports reading, writing, and manipulating an image in over 88 major formats. GraphicsMagick supports huge images on systems that support large files, and has been tested with gigapixel-size images. The product can create new images on the fly, making it suitable for building dynamic Web applications. GraphicsMagick may be used to resize, rotate, sharpen, color reduce, or add special effects to an image and save the result in the same or differing image format. It has a command line interface or it can be invoked from programs written in most languages. It runs on all major operating systems. With some modification, language extensions for ImageMagick may be used.

In addition, NESDIS has developed two tool suites to satisfy particular requirements of product generation applications. Whether these tools can be adapted to satisfy other application requirements will be determined as the evaluation process continues.

8. The Coastwatch Data Analysis Tool (CDAT) is used to produce high resolution products from the AVHRR in mapped Mercator and satellite (unmapped) projections. An extensive collection of utilities have been developed, many of which could be adapted to NPP/NPOESS input from VIIRS and other instruments to tailor Sea Surface Temperature (SST) and Ocean Color (OC) products.

9. Ozone products are encoded into ASCII, BUFR, GRIB and GRIB2 formats by potentially adaptable utilities: ROPES (Real time Ozone Processing Extended System), TOAST (Total Ozone Analysis from SBUV and TOVS), and GOME-2 (Global Ozone Monitoring Experiment 2).

During the workshop, a preliminary evaluation of each of the tools above was offered by participants. Table 2 shows these tool choices on a matrix with a preliminary assessment. A TBD cell indicates that the participants were not able to provide a consensus opinion. Products shown in blue are proprietary - acquisition and annual license fees are required. In this table, except for the Cost column, "high" means "highly capable." Costs, as well as validation of these opinions, will be determined during subsequent evaluation.

	Cost	Format-ting	Swath to Grid	Re-gridding	Pro-jection	Sub-setting
IDL	high	med	high	high	high	high
MATLAB	high	med	high	high	tbd	high
McIDAS V	med	med	high	high	high	high
NCL	low	med	lo/med	high	high	high
GDAL	low	med	low	low	tbd	high
ImageMagick	low	med	TBD	TBD	n/a	n/a
GraphicsMagick	low	med	TBD	TBD	n/a	n/a
CDAT (SST and OC)	low	TBD	TBD	TBD	TBD	TBD
Ozone Product Tools	low	TBD	TBD	TBD	TBD	TBD

Table 2: Optional Tools

Finally, Table 3 shows several tools that were discussed by participants and, during the follow-on meetings held in December, were disqualified from further evaluation for the base-line tailoring tool suite.

Tool Name	Reason for Disqualification
SeaDAS	Limited functionality
IDPS utilities	Code not currently available
GrADS	Limited functionality
AOIPS	Not currently supported
Image_Maker	Limited functionality
ECMWF Libs	Duplicates functions of the NCEP libraries
GMT	Limited functionality
Proj4	Limited functionality
MapServer	Limited functionality
EDGE	Limited functionality*
	* i.e., does not provide multiple tailoring functions

Table 3: Disqualified Tools

3. TOOL EVALUATION AND SELECTION

Figure 1 illustrates the overall framework for NDE Product tailoring and sets the stage for testing the remaining candidate tools and the selection of the baseline tailoring toolset. Tailoring tools are expected to fit within this structure, and in general, tailored products to be generated using software within the framework. If a tailored product is not generated inside the framework, it is produced by a custom product-specific program (that is, treated like a science algorithm). A cost-benefit comparison is needed to determine the whether a product-specific tool is used.

Note that the sub-setting, sub-sampling, and aggregation tools will be implemented within NDE using available libraries. Since many re-formatting tools are expected to be product and format specific, the tailoring framework must be able to accommodate the inclusion of new formatting tools.

The only tools which need to be evaluated comparatively are those which are candidates for use across all product areas, or at least multiple product areas. This reduces the list to IDL/Matlab/NCL/GDAL, noting that IDL/Matlab and NCL.GDAL are not mutually exclusive. This might limit the comparison to:

1. IDL/Matlab for gridding and re-gridding, then;
2. (Result of (1)) /NCL/GDAL for map projection; or
3. NCL/GDAL with the option to add another projector.

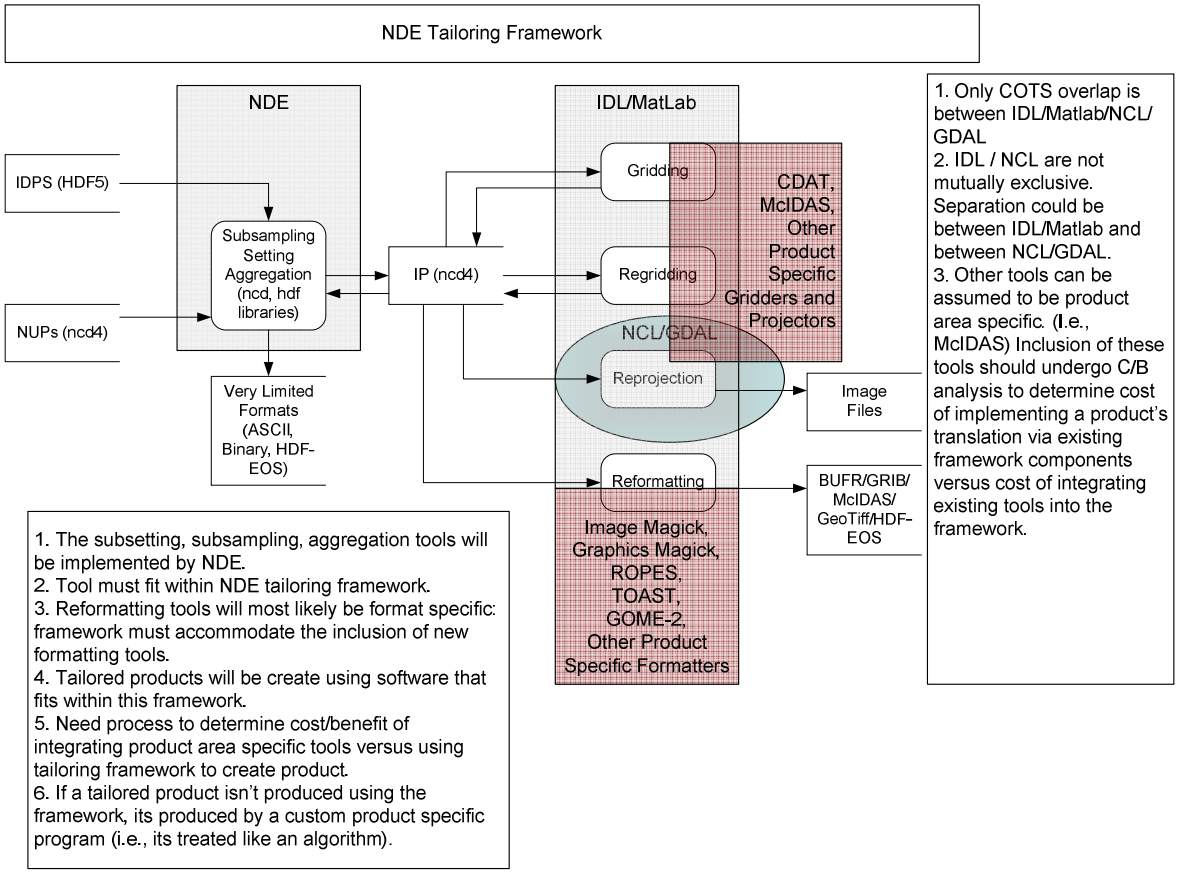

Figure 1: Framework for NDE Product Tailoring

The schedule of activities needed to set up and conduct tests to evaluate these tools and complete the baseline tool selection is presented in Table 4.

Task	Executor(s)	Completed by
Baseline NPP Tailored Product Specifications	NDE and PALS	May 30, 2008
Develop Evaluation Test Cases for (IDL/Matlab/NCL/GDAL)	NDE and PALS	May 30, 2008
Test and Report Results	NDE and PALS	Aug 29, 2008
Establish Tools Baseline	NDE Management	Sep 30, 2008
Establish Process/Interface for incorporating Tools	NDE	Sep 20, 2008

Table 4: NDE Tool Selection Activity Schedule

APPENDICES

A: Workshop Agenda

November 27th, 2007

Time	Topic	Presenter
1200-1205	Welcome/Logistics	James G. Yoe, Ph.D., NDE Systems Integration Coordinator
1205-1210	Objectives/Motivation	Jim Silva, NOAA NDE Project Manager
1210-1215	Ground Rules	Yoe
1215-1240	NDE Product Considerations	Tom Schott, NESDIS/OSD Satellite Products Manager
1240-1305	NDE System Considerations	Geoffrey Goodrum, NDE System Architect
1305-1320	EUMETSAT Data Format Tailoring Approaches	Simon Elliott, Ph.D., Operations Department EUMETSAT
1320-1335	AWIPS II	Cliff Wong, Raytheon NWS Office of Science and Technology, AWIPS Project Manager
1335-1350	NPOESS Product Formats	Richard E. Ullman NOAA/NESDIS/IPO , NASA/GSFC/NPP Algorithm Division , System Engineering Data/Information Architecture
1350-1405	Reading NPOESS Products	Ullman
1405-1430	Break	
1430-1445	NESDIS Ozone	Donna McNamara, NESDIS/OSDPD, Ozone Product Area Lead
1445-1500	NESDIS SST	John Sapper, NESDIS/OSDPD, Sea Surface Temperature

		Product Area Lead
1500-1515	NESDIS Soundings	A.K. Sharma, NESDIS/OSDPD, Atmospheric Product Area Lead
1515-1530	NESDIS Microwave Integrated Retrieval System (MIRS)	Limin Zhao, NESDIS/STAR, MIRS Lead
1530-1545	NESDIS Ocean Color	Linda Stathopolos, , NESDIS/OSDPD, Ocean Color Product Area Lead
1545-1600	NESDIS AWIPS/McIDAS	John Paquette , NESDIS/OSDPD, AWIPS Product System
1600-1700	Discussion	Yoe & Goodrum (Moderators)

November 28th, 2007

Time	Topic	Presenter
0800-0810	Objectives & Requirements Reprise	Goodrum
0810-0900	NDE Tailoring Concept	Perot Team
0910-1030	Translation Tool Discussion	Yoe & Goodrum (Moderators)
1030–1045	Break	
1045-1130	Translation Tool Discussion	Yoe & Goodrum (Moderators)
1130–1230	Lunch	
1230-1430	Subsampling, Gridding and Projection Discussion	Yoe & Goodrum (Moderators)
1430-1445	Break	
1445-1530	Subsetting, Aggregation Discussion	Yoe & Goodrum (Moderators)
1530-1545	Next Steps	Silva
1545-1600	NDE Executive Team Wrap-up	NDE

B: Workshop Attendee List

Boukabara, Sid	Perot Systems/NDE
Bunin, Stacy	Noblis/NOAA/OSD
Carpenter, Bob	Raytheon IDPS
Chiou, Erwoon	ADET Systems
Cremidis, Tino	CLASS
Cutler, Stan	Noblis/NOAA/OSD
Dahl, Glenn	NGST
Das, Bigyani	ADENT/GSFC
Donahue, David	NESDIS/OSDPD/SSD
Elliott, Simon	EUMETSAT
Elsbernd, Richard	Raytheon
Gockel, Brian	NWS
Goff, Tom	Perot Systems/NDE
Goodrum, Geof	NOAA/OSD
Graham, Emily	Perot Systems/NDE
Grant, Kerry	Raytheon
Guch, Ingrid	NESDIS/STAR
Haley, Mary	NCAR
Hay, Brennan	NESDIS OCIO
Johnson, Temp	MITRE/IPO
Kapoor, Vaishali	STC/NESDIS/ESPC
King, Thomas	NESDIS/STAR
Kopp, Thomas	Aerospace/AFWA
Leon, Darryll	NASA/SGT Inc.
Macharrie, Peter	Perot Systems/NDE
McHugh, Maurice	NESDIS/STAR
McNamara, Donna	NOAA/OSDPD
Meng, Huan	NESDIS/STAR
Miller, Shawn	Raytheon
Paquette, John	NESDIS/OSDPD
Paris, Cecil A.	NESDIS/OSDPD
Peredera, Anatoli	CLASS
Pratt, Patty	NGST
Rank, Bob	CLASS
Rao, Ananth	NASA/SGT Inc.
Reupke, Bill	Perot Systems/NDE

Ripley, Marge	GD/IPO
Roth, Gary	Perot Systems/NDE
Sapper, John	NESDIS/OSDPD
Schott, Tom	NOAA/OSD
Serafino, George	NESDIS/OSDPD
Sharma, A.K.	NOAA/NESDIS/SSD
Silva, Jim	NOAA/OSD
Stathoplos, Linda	NOAA/OSDPD
Sun, Ninghai	NESDIS/STAR
Tewari, Krishna	Perot Systems/NDE
Throwe, Jeremy	CLASS
Ullman, Richard	NASA/IPO
Van de Wouw, John	NGST
Vicente, Gilbert	NOAA/OSDPD
Wales, Carl	IPO
Wilson Ed	Perot Systems/NDE
Wolf, Walter	NESDIS/STAR
Wong, Cliff	NWS
Woodward, Rob	Noblis/NASA
Yoe, Jim	NESDIS/OSD
Zajic, Joe	NPOESS/IPO
Zhau, Limin	NESDIS/OSDPD

C: Acronym List

AIRS	Atmospheric Infrared Sounder
AIX	Advanced Interactive eXecutive (IBM's Unix-based operating system)
AOIPS	Atmospheric and Oceanographic Information Processing System
AQUA	NASA EOS Mission to collect data about the earth's water cycle (formerly named EOS PM, signifying its afternoon equatorial crossing time)
ASCII	American Standard Code for Information Interchange
ATMS	Advanced Technology Microwave Sounder
AVHRR	Advanced Very High Resolution Radiometer
BESDIS	NOAA Satellite-data Information Service
BUFR	Binary Universal Form for the Representation of meteorological data
C	C Computer programming language
C++	C Computer programming language augmented with an object repository
CDAT	CoastWatch data Analysis Tool
CDR	Critical Design Review
COTS	Commercial Off The Shelf
CrIS	Cross-track Infrared Sounder
DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
ECMWF	European Center for Medium range Weather Forecasting
EDGE	Enhanced Data rates for GSM Evolution aka Enhanced GPRS (EGPRS)
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GDAL	Geospatial Data Abstraction Library
GeoTIFF	TIFF files which have geographic (or cartographic) data embedded as tags within the TIFF file
GMT	Greenwich Mean Time
GOME-2	Global Ozone Monitoring Experiment 2
GOTS	Government Off The Shelf
GrADS	Grid Analysis and Display System
GRIB	GRIdded Binary
HDF4	Hierarchical Data Format v4
HDF5	Hierarchical Data Format v5
HDF-EOS	Hierarchical Data Format Earth Observing System
IASI	Infrared Atmospheric Sounding Interferometer
IDL	Interface Description Language

IDPS	Interface Data Processing Segment
IDV	Integrated Data Viewer
IPO	Integrated Program Office
lib	a online library
LINUX	a Unix-like computer operating system
MATLAB	Matrix Laboratory (MathWorks, Inc.)
McIDAS	The Man-computer Interactive Data Access System
MIRS	Microwave Integrated Retrieval System (NESDIS/STAR)
NASA	National Atmospheric and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NCL	NCAR Command Language
NDE	NPOESS Data Exploitation
NetCDF	Network Common Data Form
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NUP	NOAA-unique products
NWS	National Weather Service
PAL	Product Area Lead
Perl	Practical Extraction and Report Language
PHP	Hypertext Preprocessor
POES	Polar-orbiting Operational Environmental Satellite
RATS	Rough Auditing Tool for Security
RFA	Requests for Action
ROPES	Real time Ozone Processing Extended System
SADIE	Science Algorithm Development & Integration Environment
SeaDAS	Data Analysis System
SEAWIFS	Sea-Viewing Wide Field-of-View Sensor
SST	Sea Surface Temperature
STAR	Sea-Viewing Wide Field-of-View Sensor
TIFF	Tagged Image File Format
TOAST	Total Ozone Analysis from SBUV Experiment 2
TOVS	TIROS Operational Vertical Sounder
TPCTOU	Time Of Check, Time Of Use
UNIX	A trademarked computer operating system
VIIRS	Visible/Infrared Imager/Radiometer Suite
WMO	World Meteorology Organization